

# Case histories on introduced species: their general biology, distribution, range expansion and impact

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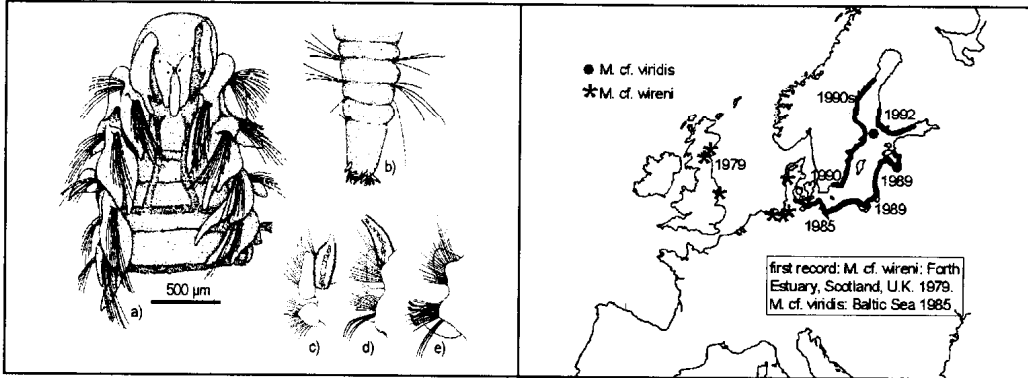
<i>Species</i>	<i>Author(s)</i>	<i>Completion date</i>
1. <i>Coscinodiscus wailesii</i> Gran & Angst, 1931	I. Laing	May 1999
2. <i>Gyrodinium aureolum</i> Hulburt, 1957	E. Macdonald	July 1999
3. <i>Undaria pinnatifida</i> (Harvey) Suringar, 1872	I. Wallentinus	Sept. 1999
4. <i>Sargassum muticum</i> (Yendo) Fensholt, 1955	I. Wallentinus	Oct. 1999
5. <i>Ensis directus</i> (Conrad, 1843)	M. Voigt	June 1999
6. <i>Dreissena polymorpha</i> (Pallas, 1771)	S. Olenin, M. Orlova, D. Minchin	Oct. 1999
7. <i>Crepidula fornicata</i> (Linnaeus, 1758)	D. Minchin	April 1999
8. <i>Balanus improvisus</i> (Darwin, 1854)	E. Leppäkoski	May 1999
9. <i>Eriocheir sinensis</i> (Milne-Edwards, 1854)	S. Gollasch	Aug. 1999
10. <i>Marenzelleria viridis</i> (Verrill, 1873)	D. Daunys, M. Zettler, S. Gollasch	Oct. 1999
11. <i>Neogobius melanostomus</i> (Pallas, 1811)	K. Skora, S. Olenin, S. Gollasch	Oct. 1999

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**Marenzelleria cf. viridis (Verrill, 1873)** Annelida, Polychaeta, Spionidae

Two forms of *Marenzelleria* recently named as Type I and Type II (sibling species) were identified after genetic and morphological studies of North Sea and Baltic Sea populations [1, 2, 3]. In several morphological features they corresponded to the diagnosis of *M. cf. wireni* (Type I) and *M. cf. viridis* (Type II) [3].



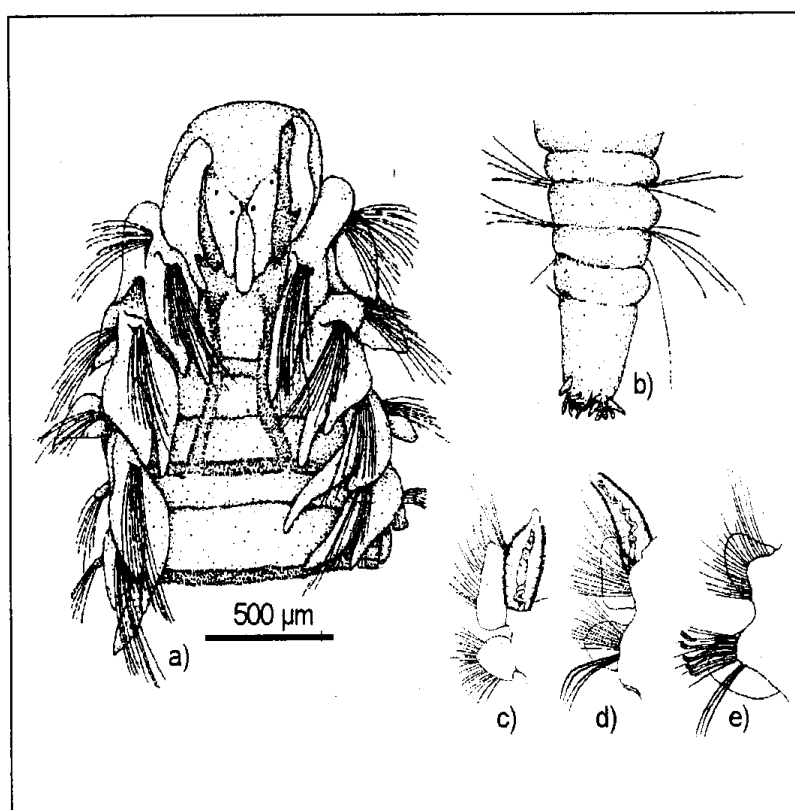
*Marenzelleria cf. viridis* (after [3]). a, b) Dorsal view, anterior & posterior end, c-d) different setigers. *M. cf. wireni*. Known distribution of *Marenzelleria cf. viridis* and *M. cf. wireni*.

**Impact:** \* = possibly harmful, \*\* = harmful, \*\*\* = very harmful, ? = not known, \$ = beneficial

Resources/Environment		Uses of the Sea		
Commercial stocks	?	Fisheries	\$	Potential food source for ground living fish [4].
Other biota	* Competition for food and space with native <i>Corophium volutator</i> . Feeding on larvae of native species. \$ In the presence of <i>Marenzelleria</i> spp. the local benthic production may increased up to ten fold [5].	Aquaculture	*	Competition for food of aquaculture organisms.
Human health	?	Water abstractions	?	
Water quality	?	Aquatic transport	?	
Habitat modification	Burrowing activities during mass occurrences may change the upper layer of the sediment: improving the oxygen content [6], but high numbers of tubes may pose sediment trap like effects. \$ *	Tourism	?	

**Vulnerable habitats:** *M. cf. wireni* (type I) colonizes soft bottom habitats in coastal zones with high salinities (meso-haline to polyhaline) or habitats with high salinity fluctuations. In contrast *M. cf. viridis* (type II) prefers oligohaline to mesohaline conditions and was not found in the western Baltic with its higher salinities [2, 3]. Suboptimal conditions may be tolerated. During hypoxic conditions the worm's metabolism can switch to anaerobic energy production and individuals survive low oxygen and high sulphide concentrations [7, 8, 9].

**Biology:** *M. cf. viridis* has a life span of approx. 3 years. Many individuals reach sexual maturity after one year [10]. Benthic adult worms inhabit vertical mucus lined burrows [6] and feed on sediment particles, planktonic, meiobenthic organisms [11, 12] and resuspended organic material [13]. In the Baltic the breeding takes place in autumn [14, 15]. Gametal development takes 4-5 months [14], although the period of spawning varies between years and different locations. Fertilised eggs occur in the water column and subsequent larval development is entirely pelagic [16]. The larvae usually grow until 16-17 setigers, when they metamorph to benthic juveniles [17]. Highest densities in the Baltic Sea are over 50,000 ind./m<sup>2</sup> with a wet weight biomass of 100 – 400 g/m<sup>2</sup> in the Darss - Zingst Bodden Chain [5].



*Marenzelleria cf. viridis*

***Marenzelleria cf. viridis* (Verrill, 1873)** Annelida, Polychaeta, Spionidae  
Common names: red gilled mud worm (Engl.)

**Identification:** Two forms of *Marenzelleria* named as Type I and Type II (sibling species) were identified after genetic and morphological studies of the North Sea and Baltic Sea populations [1, 2, 3]. In several morphological features they corresponded to the diagnosis of *M. cf. wireni* (Type I) and *M. cf. viridis* [Type II] and were described by Bick & Zettler (1997). Specimens of *M. cf. viridis* are up to 157 mm and 315 setigers long [15] with maximum width 3.2 mm [3]. The anterior margin is broadly rounded and usually notched medially. Palps are short and, in fixed specimens, do not extend posteriorly beyond setiger 10. Maximum number of branchiate setigers up to 65 and less than one third of total number of setiger. Lamella in the notopodium is initially elongate with the tip pointing distinctly dorsally. Posteriorly it becomes rounder, then appears square and then triangular on the last setigers. All setigers bear capillary setae, superior dorsal of them the notopodium are longest. Bidentate hooded hooks are present in both branches of the parapodium. Neuropodial hooks short and beyond setiger 48. Specimens have less than 20 hook-bearing branchiate setigers. Anus terminal and surrounded by up to 8-10 relatively short anal cirri besides small anal papilla.

**Diagnostic features to distinguish adult *Marenzelleria cf. viridis* and *M. cf. wireni* (after 3).**

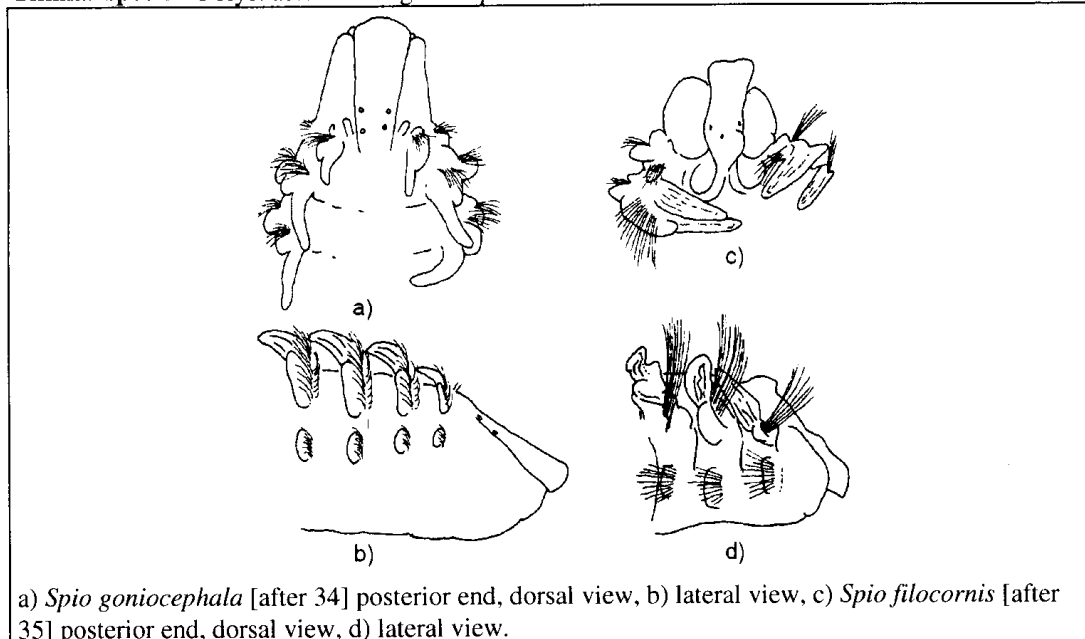
Taxonomic feature	<i>M. cf. viridis</i> (type II)	<i>M. cf. wireni</i> (type I)
Nuchal organ	up to setiger 3	up to setiger 2
Number of branchiate setigers	max. 65	max. 130
Neuropodial hooded hook	not beyond setiger 48	not beyond setiger 42 or 46
Number of branchiate setigers with hooks	< 20	> 20
Number of anal cirri	8-10 (rather short)	12-16 (rather long)

**Generalised life history:** *Marenzelleria cf. viridis* has a life span of approx. 3 years. Many individuals reach sexual maturity after one year [10]. Benthic adult worms inhabit vertical J- or L-shaped, mucus lined burrows [6]. Adults feed on sediment particles, planktonic and meiobenthic organisms [11, 12]. However, in the Baltic several observations show, that most important food sources are fresh phytoplankton, resuspended organic material [13] and detritus containing diatoms (Jankauskiene pers. comm.). A switch to deposit feeding occurs in the absence of sufficient food content in the water column [12].

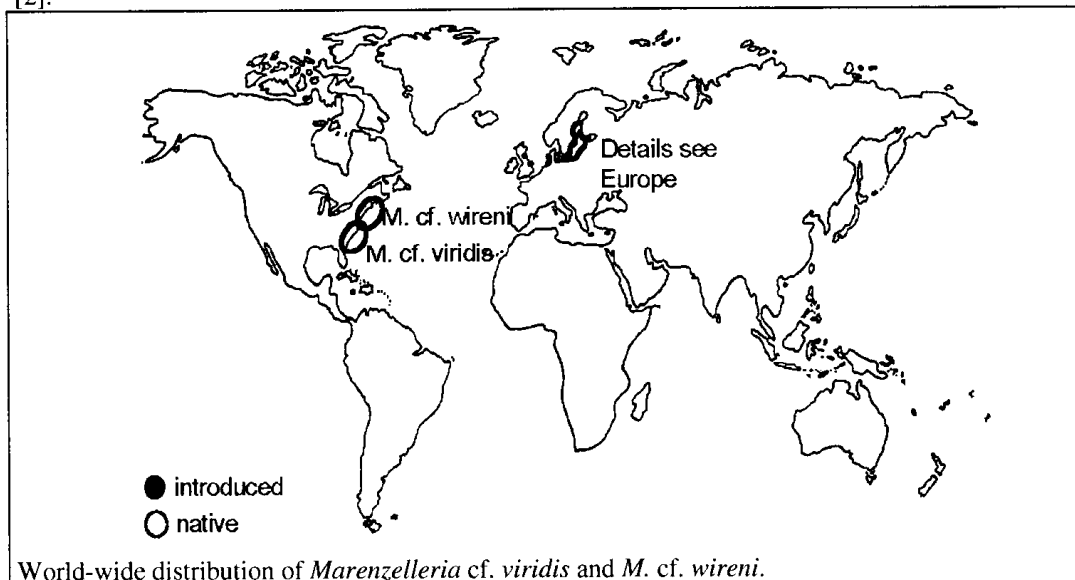
**Reproduction:** *M. cf. viridis* shows a sexual reproduction. Breeding was observed in autumn in the south-western Baltic [14] and the south-eastern Baltic [15]. Gamete development takes 4-5 months [14], although the period of maturity for spawning varies between years and different locations. The mature oocytes are disc-shaped about 155-170 µm in diameter with 10-18 cortical alveoli around the yolk [16]. Fertilised eggs occur in the water column and the subsequent larval development is entirely pelagic [16]. After the yolk reserves were consumed and development reaches the 3-setigers stage the larvae become planktotrophic. Larvae selectively feed on algae mainly smaller than 20 µm. [18]. The larvae usually grow to the 16-17 setiger stage before they undergo a metamorphosis into juveniles with a benthic life mode [17].

**Relative abundance:** Highest densities in the Baltic Sea are >50,000 ind./m<sup>2</sup> with a wet weight biomass of 100-400 g/m<sup>2</sup> in the Darss-Zingst Bodden Chain [5]. Even relative low densities of adults of *M. cf. viridis* increase the total macrofauna biomass in poor communities at least in one order of magnitude [15]. With a mean density of 300 ind./m<sup>2</sup> the surface of the *Marenzelleria*-tubes (up to 25 cm in depth) covers 0.45 m<sup>2</sup>. In the upper sediment layer (0-25 cm) *Marenzelleria*-tubes form a fraction of nearly 11 %.

**Similar species:** Polychaetes of the genus *Spio*.

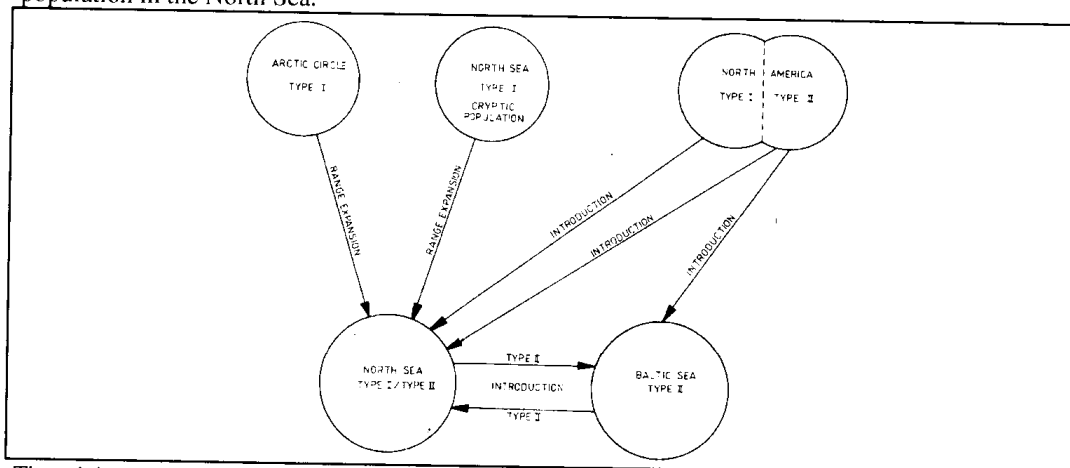


**Worldwide distribution:** The world-wide distribution of the genus *Marenzelleria* is restricted to the northern Hemisphere [22]. The native region of *M. cf. viridis* (Type II) is the Atlantic coast of North-America: Currituck Sound (USA, North Carolina), Trippe Bay (Chesapeake Bay), Chester River (USA, Virginia and Delaware) and Ogeechee River (USA, Georgia). The Chesapeake Bay and Currituck Sound were identified as the most probable origin of *M. cf. viridis* in Europe [1]. *M. cf. wireni* (Type I) is native to the following North American regions: Great Sippewisset Salt Marsh, Barnstable Harbour (USA, Massachusetts), Westport River and Cape Henlopen (USA, Delaware) [2].



**Range Expansion in Europe:** The first dense population in Europe was recorded from the Forth Estuary (Scotland) in 1979. The specimens collected were identified as *M. wireni* [19]. The spread of the species was documented by further records in the estuaries of Tay (Scotland) [20], Humber (England), Ems (The Netherlands & Germany), Weser, Elbe (Germany) and the Ringkøping Fjord (Denmark) [21, 22]. In 1985 the first specimens of *Marenzelleria cf. viridis* were found in the Baltic Sea [23]. By 1992 it occurred at several coastal areas along the Baltic up to the Finnish coast [5, 22]. *Marenzelleria cf. viridis* was found at Umeå near Stockholm, Sweden, too [33]. The species distribution is restricted to coastal waters, estuaries and shallow bays.

**Invasion patterns:** The species is often described as motile [12, 24, 5]. Its spread is often associated with dispersal and/or long development of planktonic larvae. Even eggs developed up to pre-trochophore stage are capable of small swimming movements using apical cilia [16]. Recruitment of pelagic larvae, which could be transported into a new habitats by currents may lead to successful establishment of local populations. Colonisation by benthic juveniles and adults also may occur if recruitment of pelagic larvae is limited [32, 15]. Surface movements or swimming (spiral motion) of adult worms may occur in response to physical disturbance [12]. Nocturnal swimming of worms with ripe gametes was also observed in Lafayette River (USA, Virginia) and is therefore most probably associated with reproduction [31]. The transport as larvae in the ballast water of ships is likely. However, in Europe it may have expanded its range from the Arctic or from a cryptic population in the North Sea.



The origins and possible immigration routes of the European *Marenzelleria* spp. (after [2]).

**Abiotic factors:** Limiting factors for species distribution varies in different areas within the Baltic. Unsuccessful recruitment and low densities in the offshore areas of the Pomeranian Bay and Arkona Basin were attributed to food limitation [32]. Absence of juveniles, low densities and distribution of adults, and statistically significant changes in fitness of *M. cf. viridis* specimens in the Curonian lagoon are likely to be related to the extremely low mean annual salinity values (0.1-1.8 psu) [15]. However, in the Gulf of Riga the highest densities were found near the outflow of the three largest rivers [25]. In the south-eastern Baltic the species was found between 1.5 and 55 m depth [26], whereas in the Arkona Basin the lower limit did not exceed 30 m [13]. In the south-western Baltic *M. cf. viridis* invades depths between 0.2 and 30 m. Observation of a single adult specimen in the Bornholm Basin at a depth of 90 m was reported by Kube et al. (1996). *M. cf. viridis* is resistant to higher concentrations of hydrogen. However if exposed to anoxia the species shows only a moderate resistance compared to other marine polychaetes [27, 7, 8]. Laboratory investigations showed that the species may efficiently use oxygen during hypoxia, which might indicate the ability for successful spread to habitats with frequently reduced oxygen conditions [9]. Complete local species extinction after severe anoxia and the ability to withstand short term hypoxic events was confirmed by field

observations [32]. Species re-establishment depends on the success of the larval recruitment and immigration ratio of adults [32, 15].

Temperature	Highly tolerant towards lower temperatures in oligohaline and mesohaline habitats [28].
Salinity	Highly tolerant to very low salinities and their temporary fluctuation [29]. Failed to reach maturity within 5 months at salinities >25 psu and gametes were less ripe than usual below 1.5 psu [16]. No successful larval development was observed below 5 psu from the egg to the benthic juveniles. However the 4-setiger larvae are able to metamorphose into the benthic life mode above 3.5 psu [16]. Adults prefer oligo- to mesohaline habitats [13, 8] and are more resistant than juveniles [29].
Oxygen	Tolerant to short term oxygen deficiencies [32, 8]. One of the best adapted species to long-term oxygen deficiencies among marine and brackish polychaetes [29].
Hydrogen sulphide	Detoxification mechanisms and survival in long-term sulphide exposure have been shown [7, 9]. The survival rate was not reduced in the presence of sulphide [28] and <i>M. cf. viridis</i> is better adapted than <i>M. cf. wireni</i> to cope with higher sulphide concentrations [30].

**Further likely areas for colonisation:** The species has a wide range of tolerance of salinity and temperature. The potential range of this species is expected to include boreal regions, South America, the southern coastline of Australia, Tasmania and New Zealand and South Africa.

**Main vectors:** Recruitment of pelagic larvae transported into a new habitats by currents may result in the successful establishment of local populations, supported by the long pelagic larval phase (>3 weeks) [17, 16]. Colonisation of benthic juveniles and adults may occur, if recruitment of pelagic larvae is limited [24, 15]. The North Sea species (*Marenzelleria cf. wireni* type I) could have been introduced as a larvae in the ballast water of ships or it may have expanded its range from the Arctic or from a cryptic population in the North Sea [2, 21]. It is more than likely that *M. cf. viridis* (type II) was introduced into the Baltic via a human mediated vector [2]. As *M. cf. viridis* (type II) also exists in the Elbe river (North Sea region), the species could have colonized the Baltic from the North Sea region or vice versa [2].

**Control measures/management options:** Not known.

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